

**APPRAISAL REPORT**  
**Holyoke, Massachusetts**  
**Connecticut River**

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**FILE COPY**

## **Local Flood Protection**

**October 1985**



**US Army Corps**  
**of Engineers**  
**New England Division**

APPRAISAL REPORT  
LOCAL PROTECTION PROJECT  
HOLYOKE, MASSACHUSETTS

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## I. INTRODUCTION

### A. Background

The city of Holyoke, Hampden County, Massachusetts is located along the west bank Connecticut River approximately 85 miles above the its mouth. The Holyoke Local Protection Project (LPP) is a unit in the comprehensive flood protection plan for the Connecticut River Basin authorized by the 1938 Flood Control Act and modified by the 1941 Flood Control Act. The Holyoke LPP actually consists of two flood damage reduction works: the Holyoke and Springdale projects.

### B. Authority

This study was accomplished under authority derived from EC 11-2-147 which provides direction to review the adequacy of completed LPP's which were specifically authorized by Congress. Development in watershed areas and new information on basin hydrology since the project's construction may warrant an updated analysis of the degree of protection being realized. The objective is to determine whether it is advisable to modify the structure due to changes either in the area being protected or to make changes to the project to improve its viability, safety, and reliability.

### C. Purpose and Scope

The purpose of this investigation is to assess and document the adequacy of the existing LPP on the Connecticut River through Holyoke, Massachusetts, and determine if modification is advisable and warrants further Federal study.

The study process is divided into two phases - reconnaissance and feasibility. In reconnaissance, modifications to the project are screened from the standpoints of economic, environmental, engineering integrity, and safety considerations. The detail used is strictly at the level of initial appraisal. Items of local cooperation, both past and future, are addressed when an affirmative action is recommended.

If warranted, the feasibility phase would detail the actual modification alternatives and recommend a particular course of action. The recommendation would be based on a comparison of each alternative's expected accomplishments.

The scope of this particular report is of a reconnaissance nature. The objectives are:

- Compile existing information
- Establish the need for modification
- Identify modification opportunities
- Determine preliminary feasibility of modifications
- Recommend future course(s) of action

#### D. Public Coordination

On 11 April 1985 personnel from the New England Division (NED) visited the projects and the areas being protected. Discussions with the city's Planning Director were held regarding any future plans for the areas currently afforded flood protection and other sections of the city in the floodplain.

#### E. Other Studies

Beginning in the 1930's the Connecticut River's flood problems became the subject of much study, most of it by the Corps of Engineers. There have been over 25 in-depth reports prepared as a result of Congressional directives and authorizations. In addition, a multi-agency Coordinating Committee issued their "Comprehensive Water and Related Land Resources Investigation" in June 1970, which prompted two reports by the New England River Basins Commission (NERBC): their 1976 "The River's Reach, A Unified Program for Flood Plain Management in the Connecticut River Basin" and the 1980 "Connecticut River Basin Plan."

The most recent semi-annual inspection of the LPP was conducted on 29 May 1985. The project is in satisfactory condition and capable of performing its intended function. However, there are deficiencies, described in more detail later, which require remedial action.

NERBC's "River's Reach" examined many alternatives and approaches to solving the flood problem. One of these was raising the existing LPP's along the Connecticut River to provide more protection. In addition, NERBC recommended that investigation of nonstructural measures be undertaken.

The Federal Emergency Management Agency's (FEMA) Flood Insurance Study (FIS) became effective February 1979 when the city of Holyoke joined the regular portion of the National Flood Insurance Program.

## II. EXISTING CONDITIONS

### A. Project Area

#### 1. Description

The city of Holyoke, Massachusetts, is located in Hampden County in the southwestern part of the State. It is bordered on the east by South Hadley and Chicopee, on the south by West Springfield, on the west by Westfield and Southampton, and on the northwest by Easthampton. Holyoke is 97 miles west of Boston, 142 miles northeast of New York City and 34 miles north of Hartford, Connecticut.

Holyoke is situated at a meander of the Connecticut River. Land in the central and eastern part of the city is therefore flat and subject to flooding. The Connecticut River flood plain in Holyoke is generally low and flat, with deep, well-drained silty and sandy soils that developed on glacial outwash terraces. In one section, between the business district and Smiths Ferry, the flood plain is narrow, hilly, and consists of thin, sandy soils overlying bedrock. Heavy brush and trees characterize the sparsely developed sections of the Connecticut River flood plain to the north and south of the city's central business district. A long ridge formed by East Mountain extends from the southwestern corner of the city along the Holyoke-Easthampton corporate limit of the Mount Tom Range. The central and northern sections of Holyoke can be characterized as hilly.

Since the projects' construction there has been little change in the intensity of floodplain use. The Springdale park section in the southern part of the city has seen the most recent development, with light industrial and commercial interests occupying the area between the 200-year and 500-year flood limits. The protection measures downstream of the Springdale section prevent flooding in excess of the 500-year event. There has not been any significant new development to other properties currently offered flood protection by the LPP.

#### 2. Hydrology and Hydraulics

The climate of Holyoke is typical of New England, with warm summers and cold winters. Average temperatures range from 74°F in July to 29°F in January. The average annual precipitation over the basin is approximately 43 inches, and varies from about 36 inches along the Connecticut River Valley to more than 60 inches in the White and Green Mountains. The annual precipitation in the Holyoke area is 45 inches.

Precipitation in the northern half of the basin during the winter months is practically all in the form of snow; in the southern areas alternate periods of snow and rain can be expected. The snowfall varies from an average of less than 40 inches annually at the lower elevations in Connecticut to well over 100 inches in the northern and mountainous areas of the basin.

Early spring thaws usually diminish the snow cover in the lower elevations of Massachusetts and Connecticut before melting takes place in the higher elevations or northern area of New Hampshire and Vermont. Water content of the snow in the mountains often reaches 6 to 10 inches. The water content in the snowpack usually reaches a maximum about the middle of March.

The average annual runoff for the basin is about 23 inches or slightly over one-half the average annual precipitation. The annual runoff follows a pattern somewhat similar to the annual precipitation in that it varies from about 17 inches in the areas of lowest elevation in the main river valley north of the Massachusetts border, to more than 40 inches in the highest elevations of the White and Green Mountains. About 50 percent of the annual runoff in the central and northern portions of the watershed occurs in the spring months of March, April and May. Runoff in the lower basin during the same months, as a result of less snow accumulation, is about 40 percent of the annual.

A summary of drainage area - peak discharge relationships for the Connecticut is shown below.

Table 1  
Summary of Discharges  
Holyoke, Massachusetts

Flooding Source and Location	Drainage Area (sq. miles)	Peak Discharges Annual Chance of Occurrence			
		10% (CFS)	2% (CFS)	1% (CFS)	0.2% (CFS)
Connecticut River at Holyoke-West Springfield Corporate Limits	8,309	112,000	158,000	180,000	242,000

### 3. History of Floods

River records are continuous on the Connecticut River at Montague City, Massachusetts since 1904. The flood of record on the Connecticut River at Holyoke is the March 1936 event. The existing protection was constructed as a result of this disastrous flood. If this historical event was to recur today, stages on the Connecticut River would be considerably lower because of the operation of the system of flood storage reservoirs upstream in the basin.

Flooding may occur in the basin during any season of the year, resulting from excessive rainfall, snowmelt or a combination of both. In the spring months, flooding is usually associated with snowmelt throughout the basin, resulting in prolonged high stages on the main stem and a large volume of runoff. The floods of March 1936, and April 1960 were of this

type. The fall floods of November 1927 and September 1938 and the summer floods of August 1955 resulted from intense rainfall.

Table 2  
FLOOD DATA  
Connecticut River at  
Montague City, Mass.  
(DA = 7,865 sq. mi.)

<u>Date</u>	<u>Peak Discharge</u> (cfs)
Mar 1936	236,000
Sep 1938	195,000
Nov 1927	179,000
Jun 1984	148,000
Apr 1960	142,000
Jan 1949	139,000
Dec 1983	86,000

## B. Project Description

### 1. History

The Holyoke and Springdale local protection works are located along the west bank of the Connecticut River in the city of Holyoke. Construction of the Holyoke portion began in December 1938 and completed by October 1940. Construction on the Springdale Section began in April 1947 and was completed by February 1950. The protection works, built to a height of 3.0 feet above the maximum level of the 1936 flood, provide flood protection for about 230 acres of highly developed industrial, commercial, residential and public properties.

The Holyoke features start at the Holyoke Dam in the northern part of the city and involve about 400 feet of earth dikes and 15,600 feet of concrete flood walls downstream to the Springdale area. The Springdale earth dike abuts the Holyoke measures and extends about 4,200 feet southward and ties into high ground south of Riverside Park (See Enclosure 2).

Eighteen stop-log structures are provided at openings in the concrete flood walls. There are 36 gates and 22 gate-structures for inlet and outlet works of the existing power developments to prevent high waters from the Connecticut River backing into the mills (See Enclosure 3). During floods, the inlet of the first level canal is closed. Water which would back up into the third level canal is contained by the flood walls. The floodgates are operated by the Holyoke Water Power Company and the Holyoke Department of Public Works.

Construction costs for the Holyoke portion were about \$3.6 million in 1938 which involved non-Federal costs for land easements and right-of-ways



amounting to almost \$175,000. Construction costs for the Springdale Dike amounted to \$700,000 in 1947.

## 2. Damages Prevented

The most recent flooding events in Holyoke occurred during December 1983, April 1984, and May/June 1984. The combined effect of the system of Army Corps of Engineers flood control dams in the Connecticut River Basin above the city and the LPP reduces high river stages and flood damages. In order to estimate the damages prevented (benefits) and attribute them to the dams and the LPP, a comparison is made of the observed flows and associated damages of particular flood events with the flood protection in place and the computed flows which would have occurred without the dam system and LPP in place. Table 3 indicates that for those events nearly \$12 million at current prices in flood damages in Holyoke would have occurred within the existing flood protection system. The Holyoke LPP itself contributed to the prevention of approximately 44 percent of those potential damages. Since its completion, it is estimated that the LPP alone has prevented damages of over \$11 million in Holyoke.

Table 3  
Connecticut River Basin  
Damages Prevented Recently in Holyoke, MA  
(current price level)

Event	Observed Conditions (cfs)	<u>Computed No-Project Conditions</u>		<u>Damages Prevented Holyoke</u>	
		<u>(cfs)</u>	<u>(Damages)</u>	<u>Reservoirs</u>	<u>LPP <sup>1/</sup></u>
May/ June 1984	189,200	225,900	\$11,389,200	\$6,334,500	\$5,054,700
April 1984	99,600	114,000	218,400	171,600	46,800
Dec 1983	103,800	117,000	330,000	219,000	111,000
		TOTALS	\$11,937,600	\$6,725,100	\$5,212,500

<sup>1/</sup> Includes both the Holyoke and Springdale projects

## 3. Level of Protection

Since the March 1936 flood, the Corps of Engineers has constructed an upstream system of dams and reservoirs which have modified the floods throughout the area. Recurring March 1936 flood on the Connecticut River at Holyoke, modified by the reservoir system, would have peak discharge of about 117,000 cfs compared to the experienced flow of 230,000 cfs.

The Holyoke LPP provides protection against flood stages on the Connecticut River and backwater from the Connecticut River through the three levels of canals. The design for the project is 230,000 cfs along

the Connecticut River (the actual 1936 flood). The project can now protect against an event having an annual chance of occurrence between 1.0 and 0.5 percent (100 and 200-year recurrence intervals).

The occurrence of a Standard Project Flood (SPF), as currently modified by the existing Corps flood control dams, would result in over-topping of portions of the Holyoke LPP. The top of the Springdale section of the Holyoke dikes is 72.5 feet NGVD which is below the SPF level of approximately 75 feet NGVD. Detailed delineation of the areas and properties which would be effected is complicated because of the Holyoke canal system, but would include properties in the 3rd level canal area and downstream near Springdale Park.

#### 4. Recent Inspection

The most recent semi-annual inspection was conducted on 29 May 1985. The project is in very good condition and capable of fulfilling its intended purpose. Brush growth on the stone slope protection of the project and along the riverside banks and floodwalls was identified as needing attention. It was recommended that the areas should be treated with State approved herbicide. Failure to remove this growth could lead to structural instability of the slope protection.

### III. Future Conditions

#### A. Floodplain Development

##### 1. Land Use

The flood of record on the Connecticut River at Holyoke in March 1936 caused extensive damage. The damage survey taken after the storm, and later revised in 1946, revealed that nearly 70 percent of losses were incurred by industrial properties. A 1954 review of the damage survey indicated a recurrence of an event equal to that of 1936 would have caused about \$2.8 million (1938 price levels) in damages to the protected area in Holyoke if the LPP wasn't in place. At 1985 price level these losses would amount to nearly \$36 million. Table 4 below presents a breakdown of the 1936 flood losses by land use category.

Table 4  
Holyoke, MA  
1936 Flood Losses  
(1938 Price Level)

<u>Land Use</u>	<u>Holyoke Area</u>	<u>Springdale Area</u>	<u>Total</u>
Urban	\$261,000	\$283,800	\$544,800
Rural	4,400	--	4,400
Industrial	1,445,400	526,000	1,971,400
Highway	145,600	--	145,600
Railroad	177,200	--	177,200
Totals	\$2,033,600	\$809,800	\$2,843,400

The Springdale Industrial Park was established in 1955 in the 500-year flood plain. A 1968 review of potential flood damages through Holyoke later indicated there had been a net movement of commercial and industrial tenants into the areas since 1954. It was now estimated that a recurrence of an event equivalent to that of 1936 would result in expected flood damage, without the upstream flood control dams and LPP measures in place, through Holyoke as shown on Table 5.

Table 5  
Holyoke, MA  
Potential Flood Damage  
(without existing flood protection measures)

<u>Area</u>	<u>Potential Flood Damage (1968 P.L.)</u>
Holyoke	\$4,881,000
Springdale	2,429,400
Properties built after 1954	1,895,900
Total	\$9,206,300

A cursory field review of land use in 1985 indicated that virtually all of the flood prone properties which could benefit from increased flood protection are located in the vicinity of the Springdale Industrial Park between the 200-year and 500-year flood limits. A preliminary analysis of the benefits which could possibly be derived from a plan to increase the flood protection in the Springdale area indicates that the associated investment would not be justified.

## 2. Community Plans

The protected area is made up of primarily industrial/commercial type of development. This area is fully developed, with little room for future growth. Discussions with the city planner found that Holyoke does not have any specific strategy for the floodplain. Current use is a strong indicator of future use. Any changes that might occur would be expected to be a less intensive land use.

## B. Project Integrity

The existing LPP has performed the intended purpose over its life to date. With appropriate operation and maintenance, the project should be able to continue providing protection. However, as the semi-annual inspection report indicates, random brush growth continues to increase on the stone slope protection of the project along the riverside banks and floodwalls. If this condition were allowed to go on, the structural stability of the protective measures would be threatened and the project's purpose possibly defeated.

#### IV. CURRENT PLANNING AND DESIGN CRITERIA

##### A. Freeboard

###### 1. Requirements

There are no specified criteria with regard to the design level of protection for flood damage reduction projects. Each project should be complete within itself and provide the maximum net benefits, unless there is overwhelming justification to deviate. In urban areas the Standard Project Flood (SPF) is a design goal since potential overtopping or failure could be catastrophic. An SPF's chance of annual occurrence varies regionally, but could be as frequent as an event having a 0.5 percent annual chance.

Engineering regulations call for freeboard allowances above design grade of 2 feet for concrete walls and 3 feet for dike or levee systems. The Holyoke LPP conforms to this criteria. An SPF, however, would overtop the protection.

###### 2. Benefits

Current planning guidance allows for taking credit for expected benefits within the bottom half of the freeboard range. In the case of the Holyoke LPP, this is not applicable since the elevation of the midpoint of the current freeboard zone is below the elevation where benefits were credited to when the project was originally planned because the system of upstream reservoirs modify flood flows.

EM 1120-2-104 outlines the procedures regarding benefits for advance replacement of existing projects. A credit can be taken for extending the life of a project and realizing benefits beyond which the project would have continued to function. Since the Holyoke LPP is 45 years old, and near the end of its economic life, any modifications that extend its physical life may take advance replacement benefits. However, an engineering analysis of the structure's stability and integrity would have to be accomplished to determine just how much longer the LPP can perform its intended purpose, since advance replacement benefits can only be attributed for the period of time after the structure would naturally be unable to provide flood protection. This study does not address this issue.

## V. MODIFICATION OPPORTUNITIES

### A. Level of Protection

A plan to raise the project's levees and floodwalls 5.7 feet in order to provide SPF protection was reported in the New England River Basins Commission's (NERBC) River's Reach published in 1976. This was estimated to cost approximately \$15 million at 1974 price level's, with just a 0.2 Benefit Cost Ratio (BCR).

The upstream end of the Holyoke LPP is tied into high ground near the Holyoke Dam owned by the Holyoke Water and Power Company. Although the area immediately downstream lies within the 500-year flood plain, the intensity of current use of the old mill complex up to North Bridge Street would not support additional floodwall height.

Field verification of the level of development currently occupying the flood plain in the southern reaches of Holyoke, specifically the Springdale section, indicates a limited benefit to raising the dike through here. There are many large, light industrial interests west of Main Street and bounded by the Conrail tracks. If the dike was raised from Cabot Street southward, the entire Springdale section would be protected from a 500-year flood. Currently the project provides 200-year protection.

The incremental benefits between the 500-year and 200-year levels of protection for the Springdale area are estimated at \$47,000 annually. Raising the dike the needed 5 feet from Cabot Street southward would cost about \$2 million total or \$170,000 annually. The resulting BCR is 0.3, indicating such a plan would also not be economically feasible.

### B. Protected Area

The river banks upstream of the Holyoke Dam are high and subject to pool fluctuations for hydropower generation. The flood plains are limited. Extending the LPP in this direction would not result in any appreciable benefit.

The downstream end of the project along Main Street meets the Connecticut's high river banks south of Springdale. Here, the flood plain is confined to the river itself along Springfield Road. Extending the dike system in this direction would not achieve any significant flood damage reduction at this time.

## VI. CONCLUSIONS

An increased level of flood protection or extension of the protected area at the Holyoke LPP is not needed at this time. The project itself is in good condition and expected to continue to perform its intended purpose.

Brush growth along the project's features needs attention. Proper operation and maintenance are local requirements and as such, removal of the brush and vegetation is the city of Holyoke's responsibility.

## VII. RECOMMENDATIONS

Modifications to increase the level and extent of flood protection at the Holyoke LPP are not recommended at this time. However, due to the age of the project, another review in accordance with ER 11-2-147 should be scheduled. The Holyoke LPP will be 50 years old in 1990. This would be an appropriate time for the next review.



VIII. ENCLOSURES

June 14, 1985

Operations Division, Project Operations Branch

Honorable Ernest E. Proulx  
 Mayor of the City of Holyoke  
 Holyoke, Massachusetts 01040

Dear Mayor Proulx:

My representatives conducted the semi-annual inspection of the Federally built local flood protection project in Holyoke on May 29, 1985. I have enclosed a detailed inspection report for your review.

The project is in very good condition. However, there is an increased amount of brush growth along the stone slope protection. The growth should be removed and the areas treated with a state approved herbicide to inhibit future growth. Failure to remove this growth could lead to structural instability of the slope.

I want to thank your Mr. Moynihan and Mr. McDonald of Holyoke Gas & Electric for their cooperation during the inspection. If you require any technical assistance in the operation and maintenance of your project, please call me at (617) 647-8411 or Mr. Joseph Ledgere, Lower Connecticut River Basin Manager at (617) 249-2547.

Sincerely,

MOROCCO  
 MINIOR  
 WONG

Enclosure  
 as stated

J. C. WONG  
 Chief, Project Operations Branch

Copy furnished:

Mr. Frank Maginnis  
 Asst. Supt. Dept. of Public Works  
 24 Commercial Street  
 Holyoke, Massachusetts 01040

Mr. Craig R. Dolan  
 General Supt. of DPW  
 Conn. River Valley Flood  
 Control Commission  
 Greenfield, Massachusetts 01301

Mr. William E. Moynihan  
 Flood Control Maint. Supt.  
 24 Commercial Street  
 Holyoke, Massachusetts 01040

Mr. William Foley  
 Holyoke Gas and Electric  
 102 Cabot Street, Rear  
 Holyoke, Massachusetts 01040

BM, LCRB  
 Ops. Div. Files  
 PM, Littleville

Enclosure 1

# LOCAL FLOOD PROTECTION PROJECT INSPECTION REPORT

Project: HOLYOKE LOCAL PROTECTION PROJECT

Maintaining Agency: CITY OF HOLYOKE, MASSACHUSETTS

Type Inspection: x Semi-Annual Staff 90 Day Interim

River Basin: CONNECTICUT

Date of Inspection 29 MAY, 1985

Feature	Sat	Unsat	Deficiencies
<b>PUMPING STATIONS - STRUCTURES</b>			
INTERIOR	x		
EXTERIOR	x		
<b>PUMPS - MOTORS - ENGINES</b>			
TRIAL OPERATED	x		
GENERAL CONDITION	x		
POWER SOURCE	x		
INSULATION TESTS	x		
METAL INTAKES/OUTLETS	x		
GATE VALVES	x		
<b>GATES - DRAINAGE STRUCTURES</b>			
TRIAL OPERATED			
GENERAL CONDITION	x		
LUBRICATION	x		
<b>DIKES - DAMS</b>			
GENERAL CONDITION	x		
SLOPES/EROSION	x		
SAND BOILS/CAVING	x		
TRESPASSING	x		
SLOPE PROTECTION		x	EXCESSIVE BRUSH AND HERBACEOUS VEGETATION
DRAINS	x		
<b>STOP-LOGS - LOG BOOM</b>			
CONDITION OF LOGS	x		
AVAILABILITY OF LOGS	x		
HIGHWAY SLOTS	x		
STORAGE FACILITIES	x		
<b>CHANNELS - OUTLET WORKS CHANNEL</b>			
BANKS	x		
OBSTRUCTION CONTROL	x		

Feature	Sat	Unsat	Deficiencies
<b>CONCRETE STRUCTURES</b>			
SURFACE	X		
SETTLEMENT	X		
JOINTS	X		
DRAINS	X		
<b>MISCELLANEOUS</b>			
EMERGENCY OPER. PLAN	X		
EMERGENCY EQUIPMENT	X		
SEMI-ANNUAL REPORT			

**Inspection Party:**

JAN SZWED COE  
 JOHN PARKER "  
 MICHAEL CAPUTO "

WILLIAM MOYNIHAN  
 JACK McDONALD

CITY OF HOLYOKE  
 HOLYOKE GAS & ELECT.

**Photographs Taken:**

NONE

**Remarks & Additional Comments:**

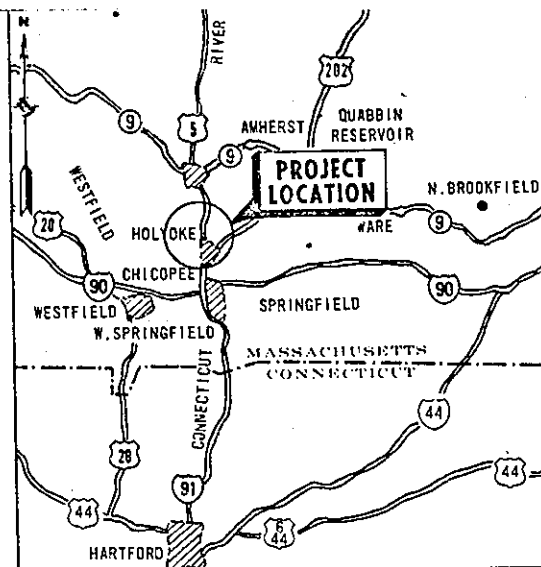
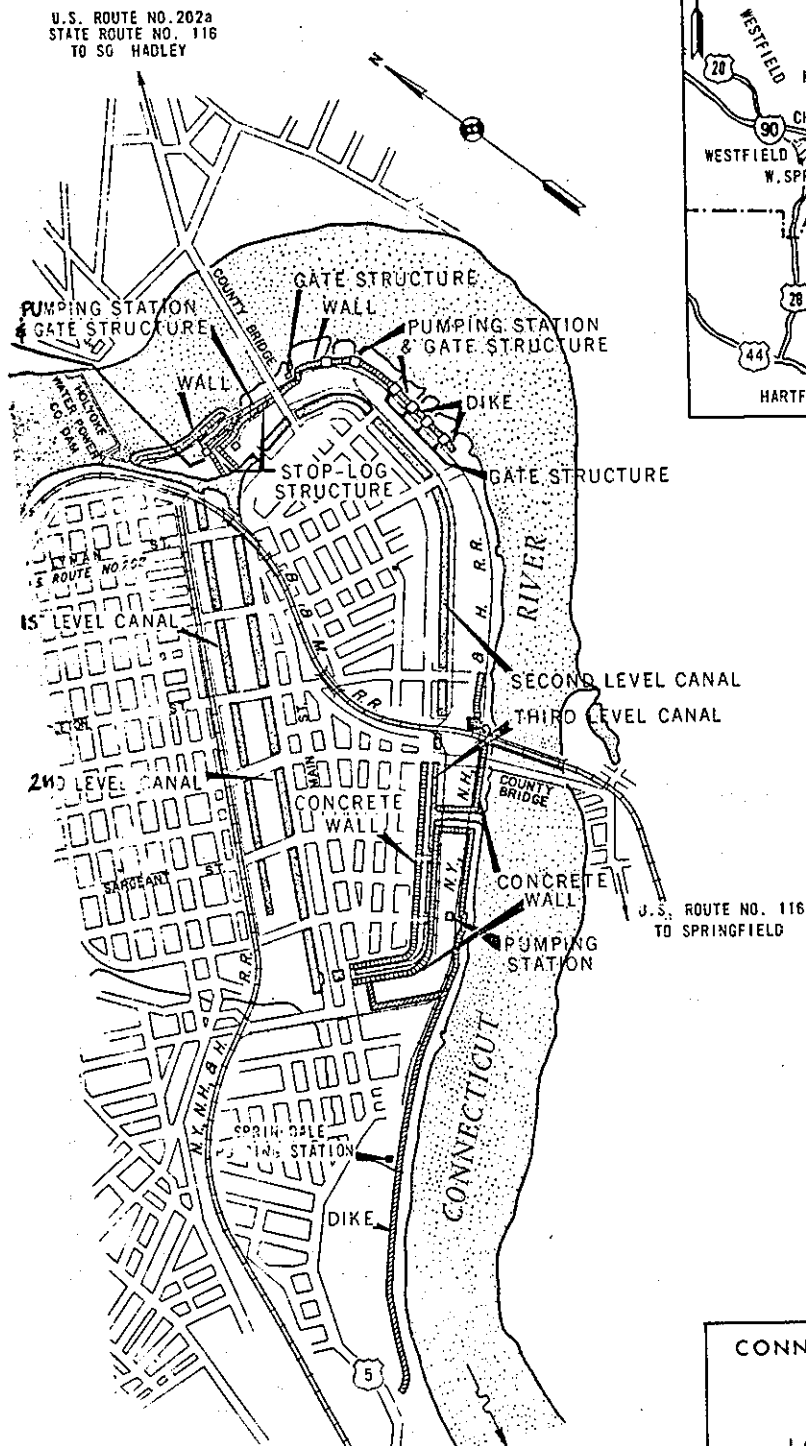
( Indicate Here Observations, Discussions, Specific Feature Deficiencies, Recommendations and any other pertinent information. Use Continuation Sheet if necessary. )

BRUSH GROWTH CONTINUES TO INCREASE ON STONE SLOPE PROTECTION AND ADJACENT TO THE FLOODWALL ON THE RIVER SIDE. GROWTH SHOULD BE REMOVED AND THE AREAS TREATED WITH A STATE APPROVED HERBICIDE SUCH AS AMMATE XN1.

FLOOD CONTROL STAFF SHOULD CONTINUE REGROUTING FLOOD WALL JOINTS WITH OAKITE AND TAR.

X ALL APPLICABLE ITEMS. IF UNSAT INDICATE SPECIFIC DEFICIENCIES, INDICATE IF NOT APPLICABLE.

DATE 30 MAY 1985	INSPECTED BY: TYPED NAME & TITLE JAN M. SZWED ACTING PARK MANAGER	SIGNATURE <i>Jan M Szwed</i>
---------------------	--	---------------------------------



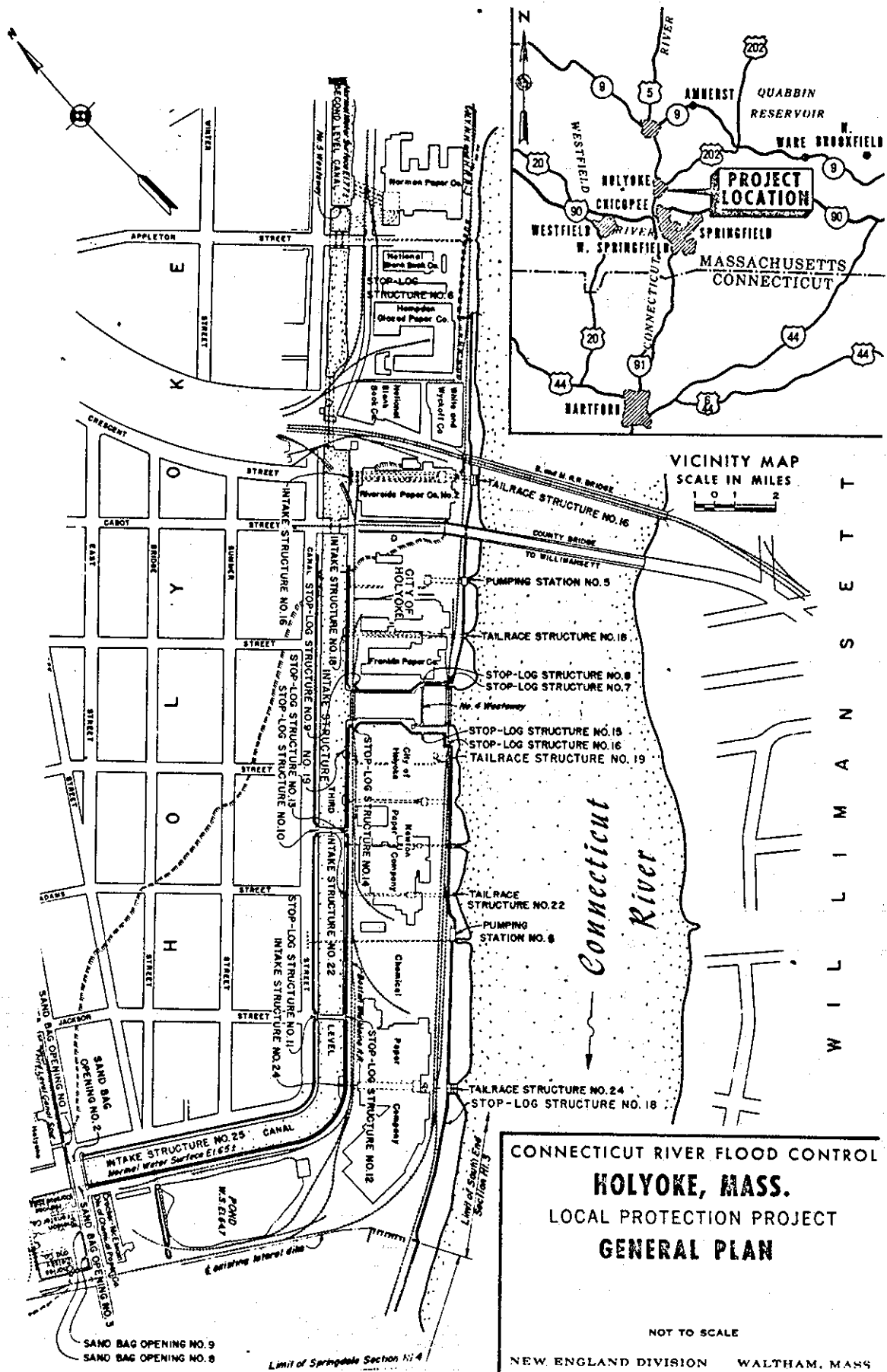
CONNECTICUT RIVER FLOOD CONTROL  
**HOLYOKE, MASS.**

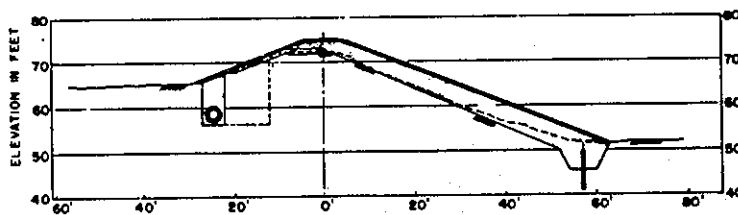
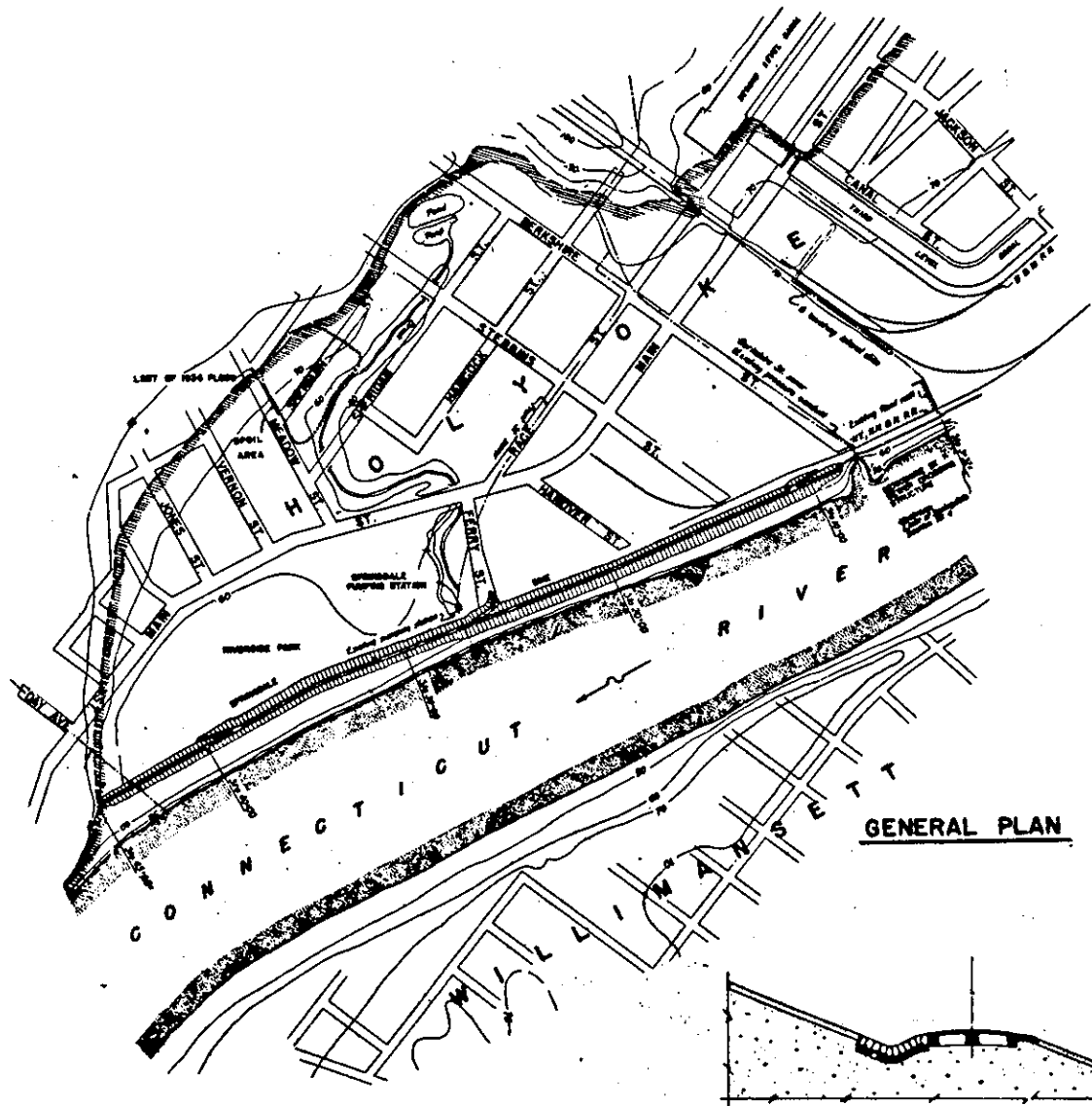
LOCAL PROTECTION PROJECT  
GENERAL PLAN



NEW ENGLAND DIVISION WALTHAM, MASS.

ENCLOSURE 2





EMBANKMENT DETAIL



DETAIL OF TOP OF DIKE

CONNECTICUT RIVER FLOOD CONTROL

**HOLYOKE, MASS.**

SPRINGDALE SECTION

LOCAL PROTECTION PROJECT

PLAN &amp; SECTIONS

NOT TO SCALE

New England Division

Waltham, Mass.

ENCLOSURE 4